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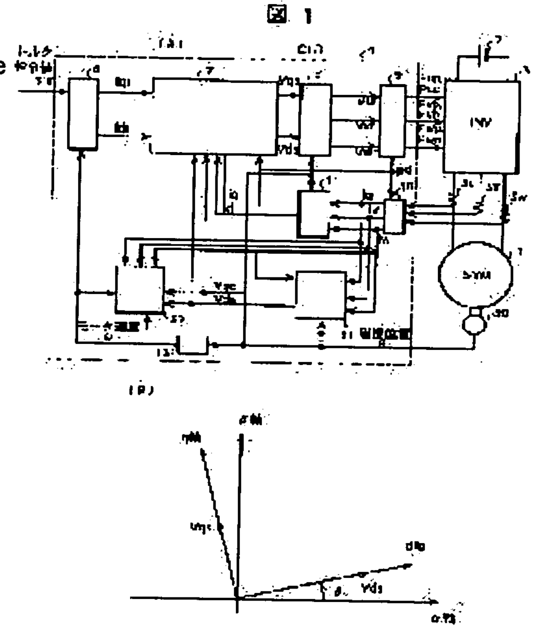
(54) MOTOR-CONTROL UNIT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a motor-control unit that conducts a motor-temperature monitor control without use of a sensor for monitoring the temperature, solving a problem that a downsizing of the motor is hindered due to the necessity of mounting the sensor that conducts a monitor control for a magnet temperature or a winding temperature in a control system that controls a synchronous motor.

SOLUTION: The control unit, which controls a power converter that applies a voltage to an AC motor and also controls the applied voltage by means of a PWM signal that synchronizes with a carrier wave, is characterized by consisting of a current-detection means that detects a current of the AC motor synchronizing with the carrier wave for generating the PWM signal of the control unit, a back-electromotive force-operation means 51 that calculates a back electromotive force by calculating a current-differential vector of every half cycle and a temperature-estimation means that estimates the magnet temperature and the winding temperature based on the relation of the back electromotive force and the magnet temperature.

図 1



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CLAIMS

[Claim(s)]
[Claim 1] It is motor control equipment characterized by to constitute from a back EMF operation means to by_which said motor control equipment calculates back EMF of a motor in motor control equipment equipped with the AC motor, the power converter which impresses an electrical potential difference to this AC motor, and the control unit which controls said applied voltage by the PWM signal, and a temperature presumption means presume the magnet temperature of said motor from said calculated back EMF.
[Claim 2] In motor control equipment equipped with the AC motor, the power converter which impresses an electrical potential difference to this AC motor, and the control unit which controls said applied voltage by the PWM signal The current change control unit which controls an electrical potential difference so that the current variation of said AC motor serves as the predetermined section 0, Motor control equipment characterized by constituting from a back EMF operation means to calculate back EMF of said motor from the output signal of the current detecting element of said AC motor, and a temperature presumption means to presume the magnet temperature and coil temperature of said motor from said back EMF.
[Claim 3] Motor control equipment characterized by establishing a magnetic pole location detection means to presume the rotator location of an AC motor based on the output signal of the current detecting element of said AC motor, in said claim 2.
[Claim 4] Motor control equipment characterized by having set to the publication of said claim 2 and establishing a switch means to switch the control which said AC motor compensates [which compensates and back EMF-detects] for every half period of said subcarrier synchronizing with a subcarrier, and to perform it.
[Claim 5] Motor control equipment characterized by being a temperature presumption means to presume magnet temperature in the publication of claim 2 from the magnetic flux of the permanent magnet presumed using the current detecting-element output of said AC motor at the time of said current change control, and to presume the temperature of motor winding from this magnet temperature subsequently.
[Claim 6] It is motor control equipment characterized by being the control unit which performs failsafe exception processing when magnet temperature or the coil temperature of a motor exceeds the allowed value set up beforehand in the publication of claim 2.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the control unit which controls a synchronous motor to high performance, and the control unit which performs temperature supervisory control of a motor without a temperature sensor especially.
[0002]
[Description of the Prior Art] Generally the control approach of performing current control of a motor is well learned for feeding back a motor current and controlling the electrical potential difference which performs proportionality and an integration operator and impresses a difference with a current command value to an AC motor as a control device which controls an alternating current load or an AC motor. For example, the approach of controlling on the d-q shaft system of rotating axes which has the rotational coordinates which were in agreement with the magnetic pole location in the current of a synchronous motor in JP,9-233845,A is indicated. Since this approach can deal with alternating current in the amount of direct currents, setting current deflection at the time of a stationary to 0 has the description that it is comparatively easy and the responsibility over a current command value is also excellent. Thus, the torque and the rate of a motor will be controlled by controlling the current passed to motor winding. And [especially] improvement and efficient operation of the utilization factor of battery voltage are aimed at.
[0003]
[Problem(s) to be Solved by the Invention] In the case of the synchronous motor using a permanent magnet, magnet temperature rises by actuation of a motor. It is known that the coil temperature of a motor shows a rapid temperature rise with this magnet temperature. Thus, if magnet temperature rises too much by actuation of a motor, magnetic flux will decrease according to the demagnetization phenomenon of the magnet. Moreover, when coil temperature rises, there is a possibility of causing burning of a coil. Therefore, it is necessary to always supervise motor temperature and to perform processing corresponding to it at the time of the abnormality rise of motor temperature. However, in order to supervise motor temperature, two or more temperature sensors, for example, magnet temperature sensor, or coil temperature sensors must be installed in a motor. And when installing these temperature sensors, the structure of the motor itself must also be taken into consideration. These will give constraint to the miniaturization of a motor. Furthermore, there are troubles, such as the fall of the dependability by failure of a temperature sensor etc. and becoming cost quantity further.
[0004] The purpose of this invention is to offer the miniaturization of a motor, cost reduction, and still more reliable motor control equipment while performing temperature supervisory control of a motor without wearing of the temperature sensor which supervises motor temperature in view of the above trouble.
[0005]
[Means for Solving the Problem] This invention is equipped with an AC motor, the power converter which impresses an electrical potential difference to this AC motor, and the control unit which controls said applied voltage by the PWM (Pulse Width Modulation) signal which synchronized with the subcarrier, and presumes back EMF of said AC motor by detecting the current of said AC motor synchronizing with said subcarrier. The control unit of said motor has the description in having constituted from a back EMF operation means to calculate back EMF of a motor, and a temperature presumption means to presume the magnet temperature of said motor from said calculated back EMF.
[0006] Moreover, the description is to have constituted from a current change control unit which controls an electrical potential difference so that the current variation of said AC motor serves as the predetermined section 0, a back EMF operation means to calculate back EMF of said motor from the output signal of the

current detecting element of said AC motor, and a temperature presumption means to presume the magnet temperature and coil temperature of said motor from said back EMF. Moreover, the description is to have established a magnetic pole location detection means to presume the rotator location of the output signal machine ****** AC motor of the current detecting element of said AC motor.

[0007] Moreover, the description is to have established a switch means to have switched the control which said AC motor compensates [which compensates and back EMF-detects] for every half period of said subcarrier synchronizing with a subcarrier, and to perform it. Moreover, the description is in being a temperature presumption means to presume magnet temperature from the magnetic flux of the permanent magnet presumed using the current detecting-element output of said AC motor at the time of said current change control, and to presume the temperature of motor winding from this magnet temperature subsequently. Furthermore, when magnet temperature or the coil temperature of a motor exceeds the allowed value set up beforehand, the description is in being the control unit which performs failsafe exception processing.

[0008]

[Embodiment of the Invention] Hereafter, drawing 1 explains one example of this invention. The example of (A) of drawing 1 is an example in the case of presuming the magnet temperature and the coil temperature of a motor which are used for a motor using back EMF of a synchronous motor 1, and shows the block block diagram of the motor control system which drives a synchronous motor 1 with the direct-current energy of a dc-battery 2.

[0009] The direct current voltage of a dc-battery 2 is changed into the alternating voltage of a three phase by the inverter (INV) 3, and is impressed to a synchronous motor (SYM) 1. As for this applied voltage, the following operation control is performed by the controller (CTR) 4. First, in the current command value generating section 6, d shaft current command value idr and q shaft current command value iqr are determined to torque command value taur which a motor should generate. Here, the direction of a magnetic pole location (magnetic flux) and q shaft show the direction which intersects perpendicularly with d shaft electrically, and d shaft constitutes a d-q axial seat label system, and determines the current value of each shaft orientations. The relation of a d-q shaft and an alpha-beta shaft was shown in (B) of drawing 1 .

[0010] In a synchronous motor 1, although the rate of idr and iqr is changeable under the conditions which are the same motor rate omega and generate the same motor torque tau, motor loss differs. Then, he is trying for motor loss to output optimal fewest idriqr to the current command value generating section 6 to torque command value taur in inputting the motor rate omega. In addition, the motor rate omega is detected from the variation of the magnetic pole location theta in a speed detector 13. If the rotator which has a magnet rotates, since a d-q axial seat label system will also rotate, the phase of the magnetic pole from rest frame (alpha-beta axial seat label system) is set to theta (henceforth the magnetic pole location theta).

[0011] If the value of d shaft current and q shaft current is controllable as a command value at this time, a synchronous motor 1 can generate the torque which was in agreement with torque command value taur. In addition, it may be ordered torque command value taur from the speed-control arithmetic circuit which is not directing and illustrating the value directly.

[0012] Moreover, the U phase current iu detected from current sensors 5u, 5v, and 5w, the V phase current iv, and the W phase current iw are detected by the timing of the current detection pulse Pd which synchronized with San-ya of the subcarrier of the PWM signal generator 9 in the current detecting element 10, and are changed into the d shaft current id of a d-q axial seat label system, and the q shaft current iq in the coordinate transformation section 11 (refer to drawing 5 mentioned later). In this example, although the currents detected by the current detecting element 10 are all the phase currents iu, iv, and iw of U phase, V phase, and W phase, since the W phase current iw can be searched for from iu and iv, detection of the W phase current iw may be omitted. In the current control section 7, d shaft current command value idr, d shaft current deflection of the d shaft current id, and q shaft current command value iqr and q shaft current deflection of the q shaft current iq are calculated, and d shaft electrical-potential-difference command value Vds and q shaft electrical-potential-difference command value Vqs are acquired and outputted to each current deflection by proportionality and the integral control (it is written as PI control below) operation. In addition, the method of performing non-interacting control using the motor rate omega as the control approach for compensating back EMF is also proposed.

[0013] In the coordinate transformation section 8 which makes an input signal d shaft electrical-potential-difference command value Vds and q shaft electrical-potential-difference command value Vqs, the three phase electrical-potential-difference command values Vur, Vvr, and Vwr of rest frame are calculated with the magnetic pole location theta. These three phase electrical-potential-difference command values are

inputted into the PWM signal generator 9. By the operation in the PWM signal generator 9, the PWM pulse signals Pup, Pvp, Pwp, Pun, Pvn, and Pwn of a three phase are outputted to an inverter 3. Thereby, the electrical potential difference impressed to synchronous motor SYM1 is determined (control). The control-block Fig. of (A) of drawing 1 is an example when detecting back EMF correctly, presuming motor temperature, i.e., magnet temperature, and coil temperature, and applying to a property improvement of a current control system. It is aimed at the motor control system which has the magnetic pole location sensor 50 in this example. Therefore, the magnetic pole location theta detected by the magnetic pole location sensor 50 is outputted to the coordinate transformation sections 8 and 11, a speed detector 13, etc., and is used for motor control. In (A) of drawing 1 , having the back EMF detecting element 51 and the temperature presumption section 52 and presuming-in the temperature control section 52 which presumes motor temperature from back EMF-motor temperature ** are the descriptions of this invention. These are explained below.
[0014] In the back EMF detecting element 51, d shaft of back EMF and q shaft components Vde and Vqe are computed from the phase currents iu, iv, and iw and the magnetic pole location theta of a three phase. These values are inputted into the current control section 7, and the current control characteristics at the time of rate sudden change etc. can be improved by using for the back EMF compensation of a current control system. Since back EMF generated inside a synchronous motor 1 will be compensated, adding the component of back EMF to the operation of a current control system is an approach currently widely performed from the former. However, since the method of presuming back EMF from the motor rate omega was generally adopted, a current may be changed by the excess and deficiency of compensation at the time of velocity turbulence. Moreover, when the load constitutes mechanical vibration system, vibration may be promoted by overcompensation of back EMF. This example solves these problems and can control a motor current as a current command value also at the time of rate sudden change.
[0015] The example of this invention furthermore shown in (A) of drawing 1 is explained to a detail using drawing 2 - drawing 5 . Drawing 2 is the partial block diagram having shown the contents of processing of the current control section 7. Effective/invalid of a current control system are switched by the current detection pulse Pd. In drawing 2 , a control operation is performed so that d shaft current control operation part 32 and q shaft current control operation part 31 may feed back d shaft and the q shaft currents id and iq to d shaft and q shaft current command values idr and iqr, respectively and those current deflection may be set to 0. Synchronizing with the subcarrier of the PWM signal generator 9, it is controlling [whether synchronizing with the current detection pulse Pd, the result of an operation of d shaft and q shaft current control operation part 32 and 31 is outputted or 0 is outputted, and] by d shaft and q shaft change-over sections 34 and 33 by switching for every half period of the.
[0016] The section 1 from time of day t (2n) to time of day t (2n+1) sets an output to 0, and he is trying for the section 2 from time of day t (2n+1) to t (2n+2) to specifically output the current control result of an operation, as shown in drawing 5 . That is, when it thinks as a current control system, as the average, only one half of electrical potential differences will be outputted. Then, he is trying to secure the same current control characteristic by making gain of a current control system twice usual in this control system. d shaft and q shaft electrical-potential-difference command values Vds and Vqs have been acquired by adding the value of back EMF Vde and Vqe of d shaft calculated by the back EMF detecting element 51, and q shaft with Adders 34d and 33q, respectively to the output (Vds0, Vqs0, R> drawing 1 1 reference) of the change-over sections 34 and 33 of d shaft and q shaft (refer to drawing 2).
[0017] Next, actuation of the back EMF detecting element 51 of drawing 3 is explained using drawing 5 . Drawing 5 is a timing diagram which shows the subcarrier (a) of the PWM signal generator 9, and actuation of each part. By the back EMF detecting element 51, the control section which detects back EMF in which it interferes each other inside a motor shows the block diagram to drawing 3 . this back EMF detecting element 51 -- alpha shaft current -- difference -- a detecting element 35 and beta shaft current -- difference -- it consists of a detecting element 36, the coordinate transformation section 37, d shaft back EMF operation part 38, and q shaft back EMF operation part 39. It is for detecting vector deltaia (2n). alpha shaft current -- difference -- a detecting element 35 and beta shaft current -- difference -- the current from the time of day t (2n) which the detecting element 36 inputted the phase currents iu, iv, and iw of a three phase, and was shown in drawing 5 to time of day t (2n+1) -- difference -- a current -- difference -- alpha shaft component deltaia[among vector deltaia(s) (2n)] alpha (2n), and deltaiabeta (2n) -- each current -- difference -- it detects by detecting elements 35 and 36. next, the current of such rest frames (alpha-beta shafting) -- difference -- a value -- the coordinate transformation section 37 -- a d-q shaft system of rotating axes -- changing -- a current -- difference -- d shaft component deltaiad (2n) of vector deltaia (2n) and q shaft

component deltaiaq (2n) are computed. the current which looked at delta iad (2n) and delta iaq (2n) on rest frame to the last -- difference -- they are d shaft of vector deltaia (2n), and q shaft component.
[0018] Moreover, since the output of d shaft and q shaft change-over sections 34 and 33 is 0 (refer to drawing 2), only d shaft and q shaft back EMF Vde and Vqe are outputted at the section 1 from the time of day t (2n) shown in drawing 5 to time of day t (2n+1), respectively as d shaft and q shaft electrical-potential-difference command values Vds and Vqs. case [therefore,] Vde is larger than actual d shaft back EMF of a synchronous motor 1 -- d shaft current -- difference -- value deltaiad serves as a forward value, and when Vde is conversely small, deltaiad serves as a negative value. A result with the same said of Vqe is brought. Then, in d shaft back EMF operation part 38 of drawing 3 , and q shaft back EMF operation part 39, the operation of d shaft and q shaft back EMF Vde and Vqe is performed so that delta iad and delta iaq may be set to 0, respectively. If each of delta iad(s) and delta iaq(s) is set to 0 by these operations, d shaft and q shaft back EMF Vde and Vqe mean that it was in agreement with back EMF of the actual synchronous motor 1. This d shaft and q shaft back EMF Vde and Vqe are outputted to the current control section CTR 7. It is the control approach that this detects back EMF in this example.
[0019] namely, back EMF to which the section 1 detected the back EMF detection control and the section 2 as shown in actuation of the back EMF operation part of the drawing 5 timing diagram -- the output of the current control operation part 32 and 31 -- adding -- the compensatory control of motor back EMF, and ** -- control is switched by the section like. Like before, when detection presumption of back EMF was carried out only from the motor rate, it had become the cause by which excess and deficiency arose and the property of a current control system was reduced between actual back EMF. On the other hand, if the electrical potential difference which is completely in agreement with actual back EMF is used for control as an amount of compensation of back EMF like this method, since original back EMF can be compensated completely, there is the description which can always maintain the property of current control to high performance. Next, drawing 4 and drawing 6 - drawing 8 explain the configuration and the concrete presumed approach of the temperature presumption section 52 of presuming temperature from back EMF Vde and Vqe detected using current change control in the back EMF detecting element 51 mentioned above. As shown in drawing 4 , the temperature presumption section 52 consists of the coordinate transformation section 53, the magnetic-flux presumption section 54, and a magnet and the coil temperature presumption section 55. From this magnet and coil temperature presumption section 55, the output of the presumed magnet temperature and coil temperature is used for failsafe processing etc. An example and drawing 8 which show the magnet temperature characteristic to drawing 6 and show the relation between magnet temperature and coil temperature to drawing 7 show a processing flow until it detects back EMF and presumes magnet temperature and motor-winding temperature clitteringly.
[0020] The magnetic temperature characteristic has the property that change deltaphi of magnetic flux phi, i.e., d phi/dt value, decreases with a magnetic temperature rise as magnet temperature becomes high, as shown in drawing 6 . And it will demagnetize, if magnet temperature rises beyond a certain temperature, and it lapses into the condition that predetermined torque stops occurring. Therefore, it becomes possible to presume magnet temperature from the rate of flux reversal, i.e., back EMF, using this property. This property may be given as a magnet simple substance property as the magnetic temperature characteristic, is measured beforehand, obtains magnetic property data, and should just memorize them.
[0021] Moreover, an example of the relation between a time or the resistance welding time, magnet temperature, and coil temperature is shown in drawing 7 . Compared with magnet temperature, the direction of coil temperature has like illustration the property of going up rapidly. If the service condition is the same, it will settle in a certain temperature from the relation between generation of heat and heat dissipation, but when the temperature rise is large, there is a possibility of causing burning of a coil. Therefore, of course, magnet temperature also needs the monitor of coil temperature, and needs the control processing corresponding to it at the time of an abnormal temperature rise. That is, if the flux reversal at the time of motor actuation is presumed from back EMF detected by the back EMF detecting element 51 and magnet temperature is known, according to the resistance welding time, coil temperature can also be presumed from drawing 7 . Thus, from the relation of drawing 6 and drawing 7 , if back EMF is known, the magnet temperature and coil temperature of a motor can be presumed.
[0022] These are explained a little in more detail. In the temperature presumption section 52, d shaft and q shaft back EMF Vde and Vqe which were detected by the back EMF operation part 51 are inputted into the coordinate transformation section 53, and coordinate transformation is performed using the magnetic pole location theta. Back EMF Vue, Vve, and Vwe of a three phase is acquired by this coordinate transformation. These back EMF is Vue=-omegaphisintheta. ...... (1)

Vve=-omegaphisin (theta-2pi/3) ...... (2)
Vwe=-omegaphisin (theta+4pi/3) ...... (3)
It comes out. Here, theta is an armature flux linkage [according / phi / to a permanent magnet] (in the text, it is abbreviating to magnetic flux phi) according [a magnetic pole location and omega] to a motor rate. In the magnetic-flux presumption section 54, the magnetic flux phi of a motor is calculated from the relation of back EMF expressed with the motor rate omega detected by the speed detector 13, and (1) - (3) type. The magnetic flux phi presumed from the above relation and the motor current at that time are inputted into a magnet and the coil temperature presumption section 55, and magnet temperature and coil temperature are presumed.
[0023] Next, an example of that presumed approach is described about this magnet temperature and coil temperature. In order to realize these temperature presumption, the magnet temperature characteristic shown in drawing 6 and the property which shows the correlation of the magnet temperature and coil temperature which are shown in drawing 7 are map-ized in a magnet and the coil temperature presumption section 55, and is beforehand set to it, for example. In addition, since the relation between magnet temperature and coil temperature changes with the magnitude of a motor current, the property of expressing these relation makes a motor current a parameter, and carries out a multi-statement.
[0024] Thus, by setting up beforehand the relation between the magnet temperature characteristic of drawing 6 and the magnet temperature of drawing 7 R> 7, and coil temperature, magnet temperature can be presumed from the magnetic flux phi presumed in the magnetic-flux presumption section 54, and coil temperature can be presumed from the relation between the magnet temperature further shown in drawing 7, and a motor current. The processing flow of the drawing 1 example described above is shown in drawing 8.
[0025] As shown in drawing 8 , at steps 101 and 102, the block 51 shown in drawing 3 is calculated. step 101 -- a current -- difference deltaiaalpha and deltaiabeta are calculated (blocks 35 and 36 of drawing 3 R> 3). At step 102, the detection operation (blocks 37, 38, and 39 of drawing 3) of back EMF is performed. Back EMF as the result of an operation is the output signals Vde and Vqe of drawing 3 . It asks at step 103 from this detected back EMF by the presumed operation (operation of the coordinate transformation section 53 of drawing 4 , and the magnetic-flux presumption section 54) of flux reversal deltaphi. In order to presume magnet temperature and coil temperature in step 104 based on magnetic-flux deltaphi calculated at this step 103, processing of a magnet and the coil temperature presumption section 55 is performed. That is, magnet temperature and coil temperature are presumed from the relation of drawing 6 memorized beforehand and drawing 7 (block 55 of drawing 4). Next, at step 105, it judges whether the magnetic temperature rise and the temperature rise of a coil exceeded the upper limit defined beforehand. When it is over the upper limit, control processing for the failsafe of controlling a motor halt or a motor current, as shown in step 106 is performed. Current inhibitory control may be performed depending on a upper limit. Moreover, if either a magnet or coil temperature exceeds a upper limit, failsafe processing of step 106 will be performed.
[0026] In addition, coil temperature can be presumed from magnet temperature by map-izing relation like drawing 7 beforehand in consideration of changing as an approach of presuming coil temperature from magnet temperature, according to a motor current, as stated so far, and drawing and mathematizing the relational expression of setting storage or magnet temperature, and coil temperature etc. That approach is not limited to this example. Moreover, compared with the back EMF detection control performed synchronizing with the subcarrier described previously, the time amount to which magnet temperature rises is very long. Therefore, when restricting to presumption of magnet temperature and coil temperature, even if it calculates back EMF with a comparatively long time interval, it can fully respond.
[0027] The above was the example of this invention, presumed detection of motor back EMF was carried out only using the current sensor, and how to presume motor temperature from back EMF was described. Thereby, motor temperature can be detected without a temperature sensor and there is effectiveness whose processing at the time of the abnormalities in motor temperature is attained. Furthermore, installation of a temperature sensor becomes unnecessary and the system of low cost can be offered.
[0028] Drawing 9 is the block block diagram of a motor control system having shown other examples of this invention. It is a primary difference to carry out as compared with drawing 1 by impressing the detection approach of back EMF in the back EMF detecting element 56 and compensation of back EMF to each phase voltage of the rest frame instead of the current control section 7. The partial configuration and the operation approach of the current control section 7 in drawing 9 are shown in the block diagram of drawing 10 R> 0. The operation almost the same as the example of drawing 1 and same is performed. The point that drawing 9 differs from drawing 1 is only not adding back EMF Vde and Vqe, and omits explanation. That is, in

drawing 2 , although Adders 33q and 34d were performing the add operation of Vde and Vqe, this part does not exist, and others are the same. The block block diagram of the back EMF detecting element 56 in this example is shown in drawing 11 . first, a current -- difference -- a detecting element 40 -- the timing of the current detection pulse Pd -- the current of each phase from time of day t (2n) to time of day t (2n+1) -- difference -- values delta iu (2n), delta iv (2n), and delta iw (2n) are computed. These values have the same information as deltaiaalpha (2n) of drawing 3 , and deltaiabeta (2n). Since from time of day t (2n) before time of day t (2n+1) only controls an inverter 3 also in the control system of drawing 9 by making back EMF Vue, Vve, and Vwe of each phase into applied voltage the current of each phase -- difference -- it calculates by U phase, V phase, and W phase back EMF operation part 41, 42, and 43 so that delta iw (2n) may serve as values delta iu (2n), delta iv (2n), and 0. that is, it was shown in drawing 3 -- as -- back EMF of q shaft and d shaft -- the current of alpha shaft and beta shaft -- it is the approach which does not search for from difference deltaiaalpha and deltaiabeta, but is searched for from delta iu, delta iv, and delta iw. Therefore, as for the output of operation part 41, 42, and 43, back EMF for a three phase is acquired. So to speak in this example, the output of drawing 11 corresponds [said example and the value corresponding to the output of the block 53 of drawing 4 R> 4]. Back EMF of the actual synchronous motor 1 can be acquired by the convergence operation. 40 of drawing 11 -- a current -- difference -- it is detection operation part.

[0029] thus, a current -- difference -- about the view which calculates back EMF from a value, it is almost the same as the example shown by drawing 1 . Next, the block of the temperature presumption section which presumes motor temperature is shown in drawing 12 R> 2 from back EMF Vue, Vve, and Vwe acquired by U phase, V phase, and W phase back EMF operation part 41, 42, and 43. In drawing 12 , the difference from drawing 4 is only that there is no coordinate transformation section 53, and presumes phi by the above-mentioned (1) - (3) type. The magnet temperature of a motor and coil temperature can be presumed by carrying out as well as drawing 4 mentioned above according to the processing flow shown in drawing 8 about the concrete temperature presumption approach. Therefore, the same effectiveness as the drawing 1 example is acquired.

[0030] Drawing 13 is the block diagram of a motor control system having shown the example for improving the property at the time of motor rate sudden change rather than the conventional current control without using a magnetic pole location sensor. As compared with drawing 9 R> 9, it is primary differences that there is no drawing 13 of 50 magnetic pole location sensor and to detect back EMF and the magnetic pole location theta by the magnetic pole location detecting element 12. The block block diagram of the magnetic pole location detecting element 12 which performs important processing in this example is shown in drawing 15 . The difference between the back EMF detecting element 56 (drawing 11) of the drawing 9 example and the magnetic pole location detecting element 12 (drawing 15) in the drawing 13 example is having the magnetic pole location presumption section 44. namely, the timing of the current detection pulse Pd -- a current -- difference -- a detecting element 40 -- the current of three phase each phase -- difference -- a value, and delta iu, delta iv and delta iw are computed, and it calculates by the back EMF operation part 41, 42, and 43 of U phase, V phase, and W phase. The control operation which detects back EMF is the same as the case of drawing 11 (block 56) of the drawing 9 example. thus, a current -- difference -- about the view which calculates back EMF from a value, it is almost the same as the example shown by drawing 1 . Next, phase theta[of back EMF Vue, Vve, and Vwe to back EMF acquired by U phase, V phase, and W phase back EMF operation part 41, 42, and 43] q (the negative direction of q shaft) can be calculated. The block which performs this is the magnetic pole location presumption section 44 of drawing 15 . Since this back EMF Vue, Vve, and Vwe has the relation shown with a formula 1, a formula 2, and a formula 3, it can calculate the magnetic pole location theta from these formulas.

[0031] Thus, if the system configuration of drawing 13 is performed, the control system which always secures current controllability ability is realizable without a magnetic pole location sensor. Here, although the system of drawing 13 was constituted from an approach of using back EMF, the approach of detecting a magnetic pole location using the saliency (or reverse saliency) of a synchronous motor 1, and the approach of being compatible in reservation of the current controllability by back EMF presumption may be applied. The block of the temperature presumption section 52 in drawing 13 is the same as drawing 12 , and explanation is omitted.

[0032] The processing flow in the drawing 13 example is shown in drawing 16 . it is shown in drawing 16 -- as -- step 101 -- a current -- Difference delta iu, delta iv, and delta iw is detected. The back EMF detection operation (operation of the blocks 41, 42, and 43 of drawing 15) is performed at step 102. The presumed operation 54 of magnetic flux phi, i.e., the magnetic-flux presumption section of drawing 12 , is calculated

at step 103 from this detected back EMF. Based on the magnetic flux phi calculated at this step 103, processing of the magnet and the coil temperature presumption section 55 (block 55 of drawing 12) which presumes magnet temperature and coil temperature in step 104 is performed. Relation with the upper limit of the magnet temperature presumed in step 105 and coil temperature is judged. When either is also over the allowed value among these temperature rises, failsafe processing of controlling a motor halt or a motor current, as shown in step 106 is performed. This is the same as the case of drawing 8 **. On the other hand, since the drawing 13 example does not have the magnetic pole location sensor, it calculates the magnetic pole location presumption section 44 shown in the operation of the magnetic pole location theta, i.e., drawing 15 , in step 107 after the back EMF detection operation implementation at step 102, and uses it for motor control, such as coordinate transformation.

[0033] In the drawing 9 example, it is the back EMF detecting element 55, and back EMF Vue, Vve, and Vwe is detected by the magnetic pole location detecting element in the drawing 13 example. In these examples, it added to d calculated by the current control section 7, and Vus, Vvs and Vws which changed the controlled variables Vds and Vqs on q shaft into rest frame in the coordinate transformation section 8, and has inputted into the PWM signal generator 9. Thus, back EMF inside a motor is compensated.

[0034] At this time, the direct current voltage of the dc-battery 2 changed into the alternating voltage of a three phase by the inverter 3 is changed by the operating condition of a motor. Then, in order to secure current controllability ability, with the magnitude of direct current voltage, the magnitude of the three phase electrical-potential-difference command value inputted into the PWM signal generator 9 needed to be amended, and it has amended using the direct current voltage on the basis of the controlled variables Vds and Vqs usually calculated by the current control section. Therefore, when compensating using back EMF detected as shown in drawing 9 and the drawing 13 example, amendment of back EMF similarly detected according to the magnitude of direct current voltage is needed.

[0035] The above is one example of this invention and described how it not only to detect the magnetic pole location of a synchronous motor, but to presume motor temperature from back EMF only using a current sensor. Thereby, motor temperature can be detected without a temperature sensor and there is effectiveness whose processing at the time of the abnormalities in motor temperature is attained. Furthermore, installation of a temperature sensor becomes unnecessary and the system of low cost can be constituted. As a synchronous motor, it is applicable to both cylindrical Rota and Rota with a saliency. Moreover, although how to detect and calculate back EMF as the magnetic pole location presumption approach was described, even when the motor temperature presumption approach stated to other magnetic pole location presumption approaches by this example is applied, it cannot be overemphasized that the same effectiveness is acquired.

[0036]

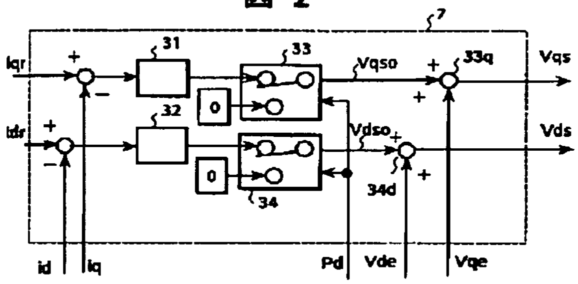
[Effect of the Invention] According to this invention, performing the usual PWM control, back EMF of a motor is detected, by using that magnetic flux can be presumed from detected back EMF, motor temperature can be presumed and temperature supervisory control of a motor can be performed. Moreover, the current controllability of high performance can always be performed by detecting back EMF on real time.

[Translation done.]

DRAWINGS

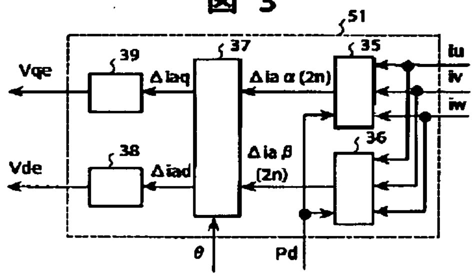
[Drawing 2]

図 2



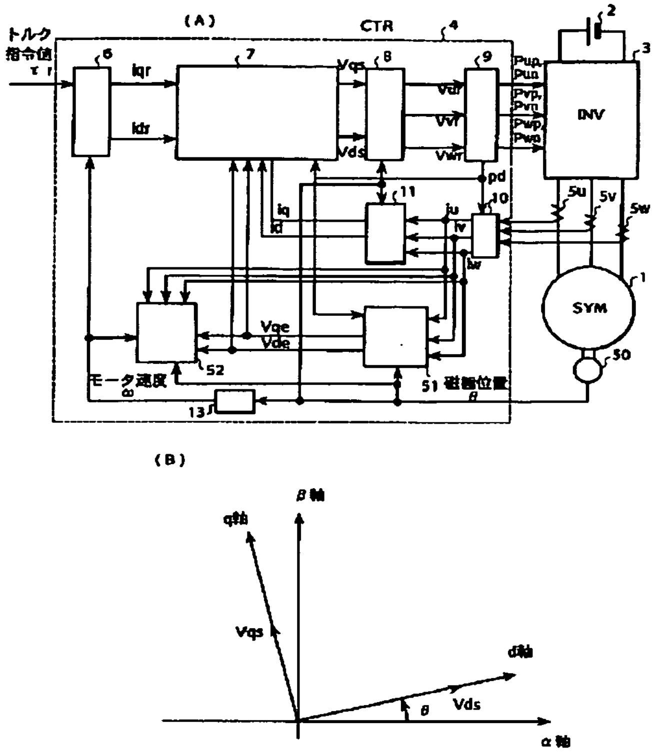
[Drawing 3]

図 3



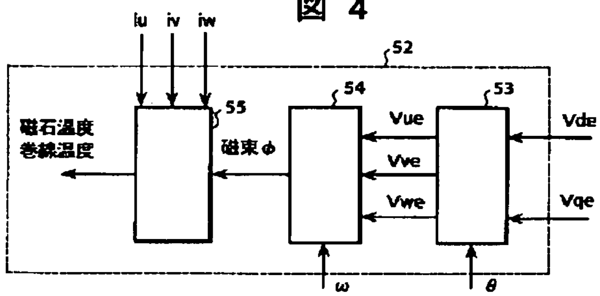
[Drawing 1]

図 1



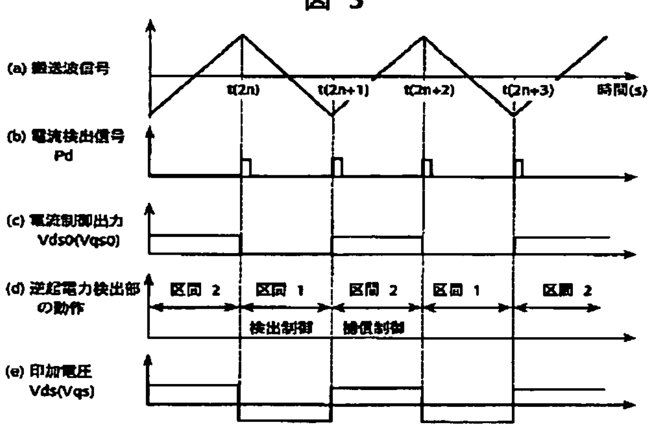
[Drawing 4]

図 4



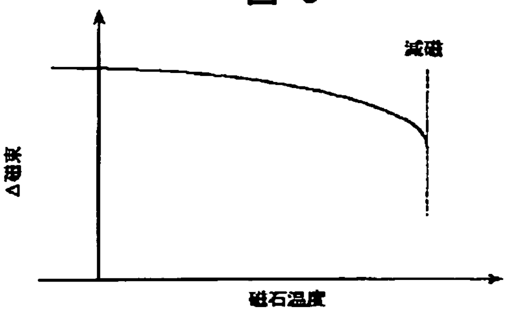
[Drawing 5]

図 5



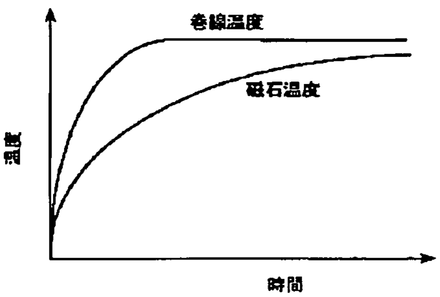
[Drawing 6]

図 6



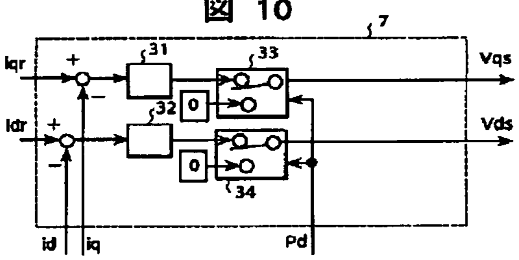
[Drawing 7]

図 7



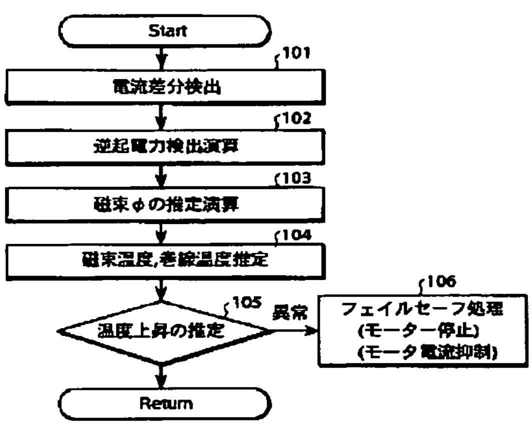
[Drawing 10]

図 10



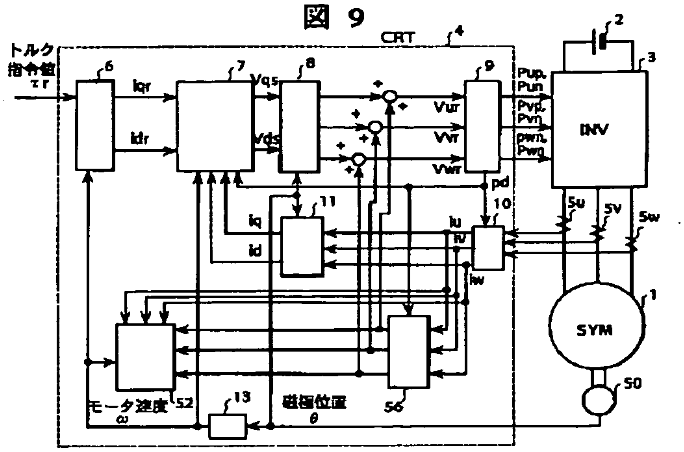
[Drawing 8]

図 8



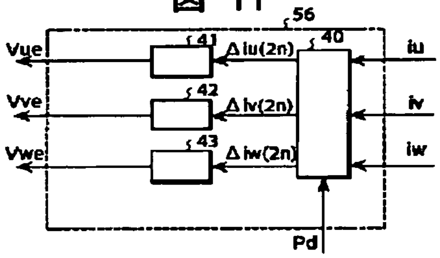
[Drawing 9]

図 9



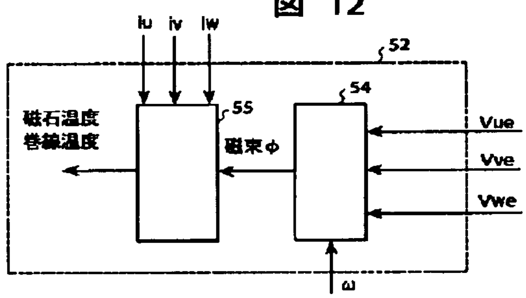
[Drawing 11]

図 11



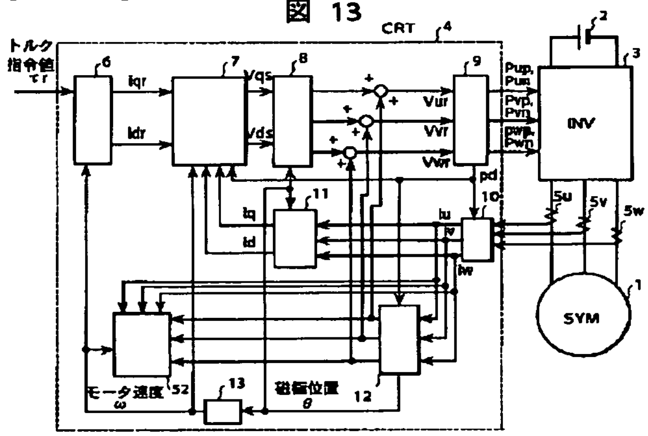
[Drawing 12]

図 12



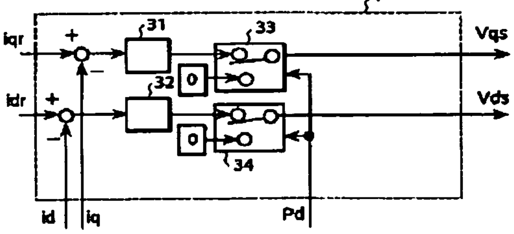
[Drawing 13]

図 13



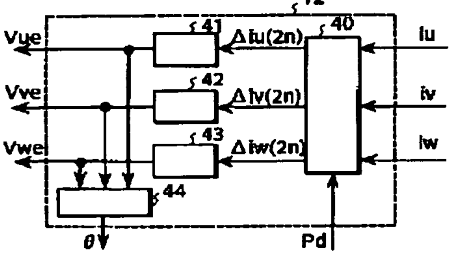
[Drawing 14]

図 14



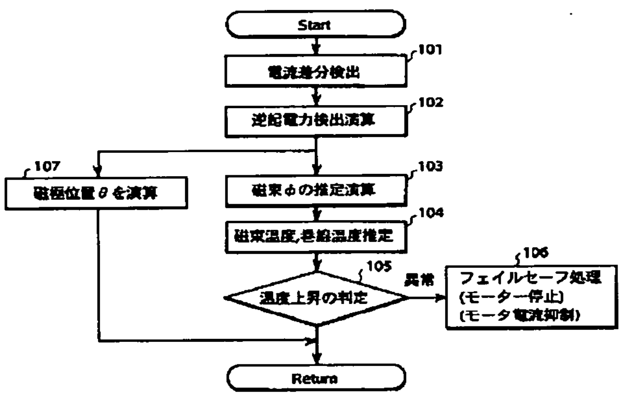
[Drawing 15]

図 15



[Drawing 16]

図 16



[Translation done.]